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DEPARTMENT OF THE INTERIOR
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BUREAU OF MINES
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INFORMATION CIRCULAR

**CONTROL OF SILICOSIS HAZARD BY SUBSTITUTION OF
QUARTZ-FREE OR LOW-QUARTZ MATERIAL FOR
SAND UNDER MINE LOCOMOTIVES**



BY

CARLTON E. BROWN AND H. H. SCHRENK

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MATERIAL FOR SAND USED UNDER MINE LOCOMOTIVES^{1/}**

By Carlton E. Brown^{2/} and H. H. Schrenk^{3/}

INTRODUCTION

Sand, which is used widely under the wheels of mine locomotives to prevent slipping, is an important source of silica dust breathed by some employees of certain mines, such as those having appreciable grades on haulageways. The sand, as received, contains dust, and other dust is produced by passage of wheels of the train over the sand. Dust is disseminated into the air by such means as handling during unloading, drying, transporting underground, sprinkling on the rails, passage of trains over sections where sand is being or has been used, and walking over deposits of sand (or the dust thereof) on the haulageway. The disseminated dust is inhaled not only by persons in the immediate vicinity but also by others to whom the contaminated air travels. The inhalation of this dust should be prevented to eliminate any possibility of the material causing silicosis (sometimes referred to as miners' consumption, miners' asthma, miners' phthisis, or miners' lung) and defined by the American Public Health Association^{4/} as:

A disease due to breathing air containing silica (SiO_2), characterized anatomically by generalized fibrotic changes and the development of miliary nodulation in both lungs, and clinically by shortness of breath, decreased chest expansion, lessened capacity for work, absence of fever, increased susceptibility to tuberculosis (some or all of which symptoms may be present), and by characteristic X-ray finding.

Substitution of a quartz-free or low-quartz material for the high-quartz sand probably is the best method for controlling this silicosis hazard. Exhaust ventilation of the sand drier, wetting or removal of the settled dust along the rails, and the use of respirators may also be used for control of this hazard. All such methods are being used.

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- ^{1/} The Bureau of Mines will welcome reprinting of this paper provided the following footnote acknowledgment is used: "Reprinted from Bureau of Mines Information Circular 7297."
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- ^{3/} Chief chemist, Health Division, Bureau of Mines, Pittsburgh, Pa.
- ^{4/} Committee on Pneumoconiosis and Committee on Standard Practices in Compensation of Occupational Diseases, Am. Public Health Assoc. Year Book, 1932-33: June 1933, pp. 101-102.

The purposes of this paper are to call attention to the hazard of silicosis from the sand, to disseminate information on quartz-free and low-quartz substitutes being used at various mines, to request information on other quartz free and low-quartz materials being used under mine locomotives, and to describe materials that are quartz-free or low in quartz.

ACKNOWLEDGMENTS

Information for this report was provided by various miners who are thought to have acquired silicosis from inhaling silica from sand used under mine locomotives; officials of the companies listed in table 1 as using quartz-free and low-quartz materials under mine locomotives; district engineers and associates of the Safety Division of the Bureau of Mines; L. H. Johnson, mining engineer, Health Division of the Bureau of Mines, and officials of the Glen Alden Coal Co. (for the information from tests with blast-furnace slag); Florence L. Feicht, physicist, Health Division of the Bureau of Mines (for the X-ray analytical information); and various others both in and out of the Bureau of Mines.

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SANDS USED UNDER MINE-LOCOMOTIVES

The requirements for materials for use in preventing slipping of the wheels of mine locomotives on rails are somewhat as follows: Hardness, sharp edges, freedom from lumping, low cost, availability, and freedom from health hazards. Sand apparently meets all these requirements except the last - freedom from health hazards.

Sand used under the locomotives in the mines of a large coal-mining company was found, by X-ray analysis,^{5/} to contain 78 percent quartz, and that used in the mines of a medium-size coal-mining company was found to contain 95 percent. The quartz content of most sands used in other mines probably is of the same order of magnitude.

The United States Public Health Service, in Bulletin 221 on anthracosilicosis, states:

An important source of silica dust in the haulageways was found to be sand used to prevent slipping of the transport motors,

and in Bulletin 270 on the health and working environment of soft-coal miners:

One important source of silica dust in the haulageways is sand used to prevent slipping of the transport locomotives.

The greatest potential silica-dust hazard was in sand-drying operations when the dry sand was screened.

^{5/} Ballard, J. W., Oshry, H. I., and Schrenk, H. H., Quantitative Analysis By X-ray Diffraction. 1. Determination of Quartz: Bureau of Mines Rept. of Investigations 3520, 1940, 10 pp.

A doctor of the Public Health Service, during the course of X-ray examinations of the chests of miners from bituminous-coal mines, in which considerable sand was used on the rails, stated that he could tell from the X-ray whether the miner worked on the haulageway, as such miners had significantly more silicosis than the others.

QUARTZ-FREE AND LOW-QUARTZ MATERIALS USED UNDER MINE LOCOMOTIVES

Table 1 contains information on some of the quartz-free and low-quartz materials that are being or have been used under the wheels of mine locomotives to prevent slipping.

Materials for use under mine locomotives, to prevent slipping, should be hard enough to scratch or "dig into" the rails and wheels rather than form a glazed layer over which the wheels slip. The hardness of the steel of the rails and wheel tires probably ranges from about 5 to 8.5 in Mohs' scale of hardness. The hardness of quartz - the main (or at least an important) constituent of most sands - is 7 in the same scale. Nonquartz materials having about the same hardness (or possibly a hardness as low as 5, provided they have the other necessary requirements) may be suitable for some tractive purposes. Actual test under the particular conditions is the best method of determining whether the material has the necessary characteristics.

TABLE 1. - Quartz-free and low-quartz materials used
under mine locomotives

Material	Source	Quartz content percent ^{1/}	Used by	Remarks
Slag from copper furnace	Tennessee Copper Co., Copperhill, Tenn., (P. Norton)	< 1	Tenn. Copper Co. mines	400,000 to 500,000 tons reported to be available at Copperhill, Tenn.
Iron-ore tailings	Iron-ore mining company	8	Hudson Coal Co., Scranton, Pa.	---
Ferro- chrome slag tailings	---	11	---	---
Slag from copper smelter	Anaconda Copper Mining Co. smelter, Ana- conda, Mont.	--	Anaconda mines, Butte, Mont.	Use discontinued because it report- edly caked in the boxes on the loco- motives and did not prevent slipping.

^{1/} Results of X-ray determinations on single samples (in most cases) collected at random. Results should be judged accordingly and accepted with caution.

The particles of the material probably should be approximately equal in all dimensions; that is, they should not be platy, fibrous, or needlelike in shape, as such particles may deposit under the wheels with their long axes oriented rather than "dig into" the wheel and rail.

The material should not absorb enough moisture to lump readily, otherwise the material will not flow from the containers on the locomotive to the rail.

The material should be readily available. Considerable quantities of traction material are needed in mines in various widely separated districts. The quantity used in different mines varies, depending upon such factors as grades, production, number of trips, and size of locomotives and cars. The amount used annually in some mines totals hundreds of tons. The annual consumption in all mines probably approximates several hundred thousand tons. Thus, thousands of tons of any material considered for tractive purposes should be (actually or potentially) available to some mining districts.

The cost of the material should be low enough to compete initially or eventually with sand, which in many localities is available at \$1 or less per ton within a few miles of the mine.

The material should be much less of a hazard to health than sand. That is, it should contain much less free silica or quartz (as little as possible and preferably less than 10 percent) and no significant quantity of other unhygienic substances, such as antimony, arsenic, cadmium, chromium, lead, manganese, mercury, selenium, tellurium, thallium, uranium, and vanadium.^{6/}

There are various common minerals and artificial abrasives that probably meet the requirements except availability and low cost. There are still fewer that meet all requirements except that of low cost. The possibility of mining and preparing material for about \$1 a ton to compete with sand seems rather remote when the cost per ton at the mine of such common substances, mined on a tremendous scale by very efficient methods, is \$1.91 for bituminous coal, \$4.27 for anthracite, \$2.68 for hematite, \$5 for magnetite, \$4.48 for crude feldspar, and \$10.75 for ground feldspar.^{7/} Mine operators probably would rather try to control the dust from the sand than to pay appreciably more for a quartz-free or low-quartz substitute for the sand. This cost factor tends to limit possible substitutes to now-worthless or near-worthless materials that would require little or no preparation. Granulated slag from blast furnaces and copper furnaces, certain ore tailings, lava and cinders, might be possibilities.

A blast-furnace slag found, by X-ray analysis, to contain: A large amount of melilite, $\text{Na}_2(\text{Ca}, \text{Mg})_{11}(\text{Al}, \text{Fe})_4(\text{SiO}_4)_9$ or a related compound; 3 percent free silica, SiO_2 , < quartz; possible trace of calcite, CaCO_3 ; and a small amount of unidentified crystalline material was tried under the wheels of mine locomotives of a large coal-mining company. The tractive properties of this material were not nearly as good as those of sand. The quantity of coal that could be hauled up an average 5-percent grade when using slag was only half as much as could be hauled when using sand. The slag deposit on the rails passed over by the trip was about 3/32-inch thick, glazed, and practically free from any gritty feeling to the touch. These results under the

^{6/} Dublin, L. I., and Vane, R. J., Occupation Hazards and Diagnostic Signs: U. S. Dept. of Labor, Division of Labor Standards, Bull. 41, 1941, 70 pp.
^{7/} Bureau of Mines, Minerals Yearbook, 1942: 1943, 1574 pp.

particular conditions should not discourage experimentation with other slags, inasmuch as large quantities of slag are available in or near many mining districts.

A granulated slag, consisting mainly of fayalite (Fe SiO_4) from a copper furnace has been found satisfactory for use under locomotives in several copper mines, as stated in table 1. Possibly other such slags also may be suitable.

Tailings from magnetite iron ore have been used under the locomotives in the mines of a large coal-mining company, as stated in table 1. Other ore tailings may be equally satisfactory. The quartz content of such tailings should be determined before use, and in general they should not be used unless their quartz content is preferably less than about 10 percent or at least somewhat lower than that of the sand in use.

Cinders might be useful after the necessary preparation or crushing and sieving, but the cost of preparation might render their use impractical. Availability is an important advantage of this material.

Some lavas might have the desired physical properties, but the cost of preparation might make their use too expensive.

There may be various other suitable materials, some of which may even be in use, especially in particular localities. The Bureau of Mines will appreciate information on such materials, so that it may be disseminated to interested mine operators.

SUMMARY

The possibility of acquiring silicosis from the inhalation of free silica or quartz dust from the sand used under the wheels of mine locomotives to prevent slipping is stated.

Information is given on efforts to control this silicosis hazard in some districts by substituting for the sand some quartz-free or low-quartz materials as iron-ore tailings and copper-furnace slag.

Other quartz-free or low-quartz materials, such as blast-furnace slags, ore tailings, cinders, and lava, are suggested for possible use under mine locomotives.

Information on other quartz-free or low-quartz possibilities and on the use of any material other than sand under mine locomotives to prevent slipping is requested.